Final Project Report to the NYS IPM Program, Agricultural IPM 2006-2007

***Title*: Evaluation of Two Parasitoids in Dairy Calf Greenhouses**

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Project locations: Cayuga, Cortland, Onondaga and Tompkins Co. Results applicable throughout the Northeast

Abstract:

Parasitoids are a critical component of a successful dairy IPM program. In the first year of this two-year study we compared individual species parasitoid releases. During Year 2 we compared the best individual parasitoid from Year 1 (*M. raptorellus*) to a 50:50 ratio of *M. raptor* and *M. raptorellus*.

House fly levels were similar throughout the study and in no time period did fly numbers exceed the threshold level of 100 spots per card. In general, producers were very good stewards of the calf bedding areas. In 2006, the average spots per card were a little higher than normal, but that can be attributed to NY having one of the rainiest summers on record. These wetter than normal conditions would have easily produced ideal conditions for more flies to be produced on these farms. Stable fly numbers increased throughout the summer on no-release farms and numbers were highest during the release period on all of the release farms.

On no-release farms, *M. raptor*, a native NY parasitoid, accounted for 97.9% successful parasitism and M. raptorellus accounted for 2.1%. On *M. raptorellus*-release farms, the released parasitoid accounted for 90.1% successful parasitism, while *M. raptor* accounted for 9.9%. On *M. raptor*/*M. raptorellus*-release farms, *M. raptor* accounted for 52.5% successful parasitism, while *M. raptorellus* accounted for 47.5%. None to very low parasitism was identified during the pre-release period and the first week of releases. Successful parasitism immediately increased on the six release farms and remained low on the no-release farms for the duration of the study. Successful parasitism averaged 5.2% on the no-release farms, 62.5% on *M. raptorellus* farms and 57.4% on *M. raptor*/*M.raptorellus* farms during the release period.

Total parasitism is the number of pupae killed by parasitoids and represents the benefit (dead flies) to farmers that the parasitoids are providing. Total parasitism averaged 21.8% on no-release farms, 65.9% on *M. raptorellus*-release farms and 67.2% on *M. raptor*/*M.raptorellus*-release farms. These data indicate that the parasitoids were removing 69-76% of flies from the calf bedding areas on *M. raptorellus*-release farms and 71-78% of flies from *M.raptor*/*M.raptorellus* release farms.

Based on these results, *M. raptorellus* and the 50:50 mix of *M. raptor and M.raptorellus* gave very similar control of the fly populations on their respective dairy farms. With the similarities taken into consideration, it merely comes down to the cost effectiveness of each parasitoid release to the farmer. To release the *M.raptorellus*, it costs less then half of what it would to release the 50:50 mix. However, it would be most beneficial to have another year to fully compare and understand the differences between the two types of parasitoid releases in the

2006 study and to make certain that the record breaking NYS rainfall in 2006 was not a factor in how the parasitoids performed. We hope to be able to accomplish this in 2007.

Background and Justification

House flies, *Musca domestica*, and stable flies, *Stomoxys calcitrans*, are two important dairy cattle pests in New York. House flies transmit diseases and are annoying, while stable flies inflict a painful bite causing weight loss and discomfort to animals.

Previous research has documented that calf areas, most often the calf hutches, are the greatest source of fly breeding on dairy farms. The reasons for this include; a small animal unable to crush developing fly larvae, manure and spilled grain mixing with spilled water and urine, management practices that utilize straw bedding over wood chips, and a 6 to 8 week period between animal introduction and bedding removal.

Large, plastic covered, half-hoop structures, resembling Quonset buildings are beginning to be used for holding large numbers of calves, replacing individual calf hutches on New York dairy farms. The benefits of these buildings are numerous (easier animal handling, healthier calves, and easier cleanup), however, there is also the potential for buildup of large numbers of fly pests. Farmers can spend thousands of dollars attempting to control flies in these facilities, usually with insecticides. However, chemical control is limited as many New York house fly populations are resistant to most of the currently registered materials as documented on New York dairies in 1987 and again in 1999 (Scott et al. 1988, Kaufman et al. 2001, Kaufman and Rutz 2002). Several farmers have reported that pest control operators are no longer willing to apply cyfluthrin, our most recently registered compound, because of house fly resistance. Reports of control failures appear even as the EPA and the chemical industry continue to cancel dairy pesticide registrations under the FQPA.

Biological control on dairy farms relies on either naturally occurring parasitoids or inundative releases of the parasitoid *Muscidifurax raptor*. However, a recent addition to the catalog of commercially-available parasitoids is *Muscidifurax raptorellus*. This parasitoid has the advantage of producing multiple offspring, which can become established more rapidly and may cost less. Studies in poultry facilities and cattle feedlots have documented the benefits of *M. raptorellus*.

Calf greenhouses are fairly new to New York and until recently we have not had the opportunity to critically evaluate the effectiveness of our dairy fly IPM program recommendations under these conditions. Our 2000 and 2001 calf greenhouse studies, funded by NYS IPM, documented for the first time the dynamics of parasitoids in these facilities. Our results showed that when *M. raptor* was released, it became the predominant species. However, following an unintentional *M. raptorellus* release, this species established itself at a low, but stable population, suggesting its potential as a biological control agent in these systems. Their success was proven in year 1 of this project, with *M. raptorellus* release farms averaging 50% successful parasitism, while *M. raptor* release farms averaging only 22.4% successful parasitism (Figures1 and 2) (Rutz et al. 2003). Based on those findings, *M. raptorellus* releases were compared to a 50:50 ratio of *M.raptor*/*M.raptorellus* releases in 2006. The purpose of these studies is to provide critical data to develop recommendations for producers as to which species of parasitoid to purchase for biological control. Additionally, the results obtained in this 2-year study will be used in our extension training programs.

Objectives

Year 1 (2003)

1. Determine the successful parasitism levels (parasitoids producing offspring) and parasitoid mortality (killed flies as a result of parasitoid attack) following releases of two *Muscidifurax* parasitoid species.
2. Observe fly population levels in facilities before, during and after parasitoid releases.

Year 2 (2006)

1. Compare releases of a 50:50 ratio of *M. raptor* and *M. raptorellus* to the parasitoid release from Obj. 1, 2003 that proved the most successful.
2. Observe fly population levels in facilities before, during and after parasitoid releases.

Procedure

Nine dairy farms with calf greenhouses were utilized in this study. In 2003, three of these farms served as control sites, three as *M. raptor* release sites and three as *M. raptorellus* release sites. In 2006, three of these farms served as control sites, three as *M. raptorellus* release sites and three as *M. raptor*/*M.raptorellus* release sites. One of the *M.raptor*/*M.raptorellus* release farms is not included in the prerelease data since they started releasing parasitoids before they were contacted to be in the study. Also, one of the no release farms mistakenly started releasing a mix of *M.raptor* and *M.raptorellus* starting on 12 June 2006. Because of this, that particular farm was changed from a no release farm to a *M.raptor*/*M.raptorellus* release farm and was not included in week 2 of the prerelease data. Each farm received approximately 500 parasitoids per calf. The release level for an individual farm was determined by averaging the numbers of calves on the individual release farm during the two prerelease visits. Release levels (number of parasitized pupae delivered) were corrected using information on estimated percent emergence provided by the commercial insectary to achieve a more precise release level. In 2006, a 50:50 ratio of the two *Muscidifurax* species was compared to the top performing release treatment from 2003, *M. raptorellus*.

The study began on 06 June 2006. The study concluded 13 weeks later on 29 August, with final spot card and sentinel pupae bag collection on 05 September. House fly densities were monitored weekly with spot cards. Stable fly densities were monitored weekly by counting the numbers of flies on the legs of 15 animals per greenhouse. This allowed us to identify potential breeding sites in the greenhouse. We monitored for natural parasitism for two weeks, followed by eight weeks of parasitoid releases and 3 weeks of post-release parasitism observations. The parasitoid release schedule followed the schedule recommended for producers through our extension program.

Successful parasitism rates were monitored weekly using the sentinel pupal bag method of Rutz and Axtell (1980). Sentinel bags (10 bags per facility; 8 X 8 cm, mesh density 5.5 squares/cm), each containing 30 live (<2 d post-purariation) house fly pupae, were placed weekly just under the surface of bedding, under the calf water buckets, an area of high potential for

fly breeding activity. Following a one-week exposure, pupae were returned to the laboratory and uneclosed flies allowed to emerge. Uneclosed pupae were then individually gelatin capped and held for parasitoid emergence. After a minimum 30-day holding period, emerged parasitoids were enumerated and recorded. Percent successful parasitism (fly pupae producing an adult parasitoid) and percent uneclosed (fly pupae killed by parasitoid attack) were calculated.

Parasitoids were purchased and distributed by Cornell personnel by shaking parasitized pupae from a container just inside the calf pen along the length of the active calf areas. Subsamples of releases were held and checked for emergence and parasitoid purity levels.

House fly populations were monitored using 7.5 x 12.5 cm white index cards placed on 10 rafters down the center of the calf facility (2-3 m above the ground). Cards were replaced weekly and the numbers of spots (fecal and regurgitation spots) on 50% of the card were counted. Stable fly populations were monitored weekly by counting the numbers of flies on the four lower legs of 15 calves per farm.

Release Farms – Farmers at the release farms were provided constructive feedback regarding fly breeding areas and instructed on the proper manure management guidelines to be followed. These included pouring waste water outside the building, removal of dead animals, bedding properly (gravel, wood chips, or saw dust) and using a nozzle on the end of the watering hose, to name a few. Actions not taken by the producer were documented (i.e. improper disposal of water) to better explain variation in adult fly populations among farms. Insecticide applications were used only as a last resort and actions taken were recorded.

Control farms – Fly management actions taken by cooperator farms were recorded. This included the uses of any insecticides, cultural controls such as sticky tapes and manure management tactics. Releases of beneficial organisms were not allowed on these farms.

Results

Average house fly densities are presented in Figure 3 for the pre-release, release and post-release periods. House fly levels were similar throughout the study and in no time period did fly numbers exceed the threshold level of 100 spots per card. In general, producers were very good stewards of their calf bedding areas.

Stable fly numbers increased throughout the summer and numbers were highest in the release period for both the *M.raptorellus* and *M.raptor*/*M.raptorellus* release farms while the no release farms steadily increased (Figure 4). Stable fly adults are difficult to control at point sources since their breeding areas are often found not only across the farm, but also in the non-farm environment. Stable fly populations develop more slowly than house flies and this data reflects past experience with this pest.

We placed over 5,300 sentinel pupae on the nine farms during the pre-release period, 21,000 during the release period and 8,100 during the post-release period. Given such large numbers of pupae, we have not been able as of yet to identify all of the parasitoids. For the purpose of this report, single emerged parasitoids are going to be assumed to be *M. raptor* and any double or more emerged parasitoids are going to be assumed to be *M. raptorellus*.

Only 81 parasitized pupae were recovered from the over 5,300 pupae placed during the pre-release period (June 06 and 13). During the release period (Jun 20 – Aug 08), a total of 243 parasitized pupae were recovered from farms on which no parasitoids were released, a total of 4197 parasitized pupae were recovered on farms where *M. raptorellus* was released and a total of 5421 parasitized pupae were recovered on farms where the 50:50 ratio of *M. raptor* and *M. raptorellus* was released. Part of the discrepancy in numbers of recovered parasitoids can be attributed to parasitoid biology. *M. raptorellus* is a gregarious parasitoid producing approximately 4 adult parasitoids per pupae, while *M. raptor* is solitary. On no-release farms, *M. raptor*, a native NY parasitoid, accounted for 97.9% successful parasitism and M. raptorellus accounted for 2.1% (Figure 5). On *M. raptorellus*-release farms, the released parasitoid accounted for 90.1% successful parasitism, while *M. raptor* accounted for 9.9%. On *M.*

raptor/*M. raptorellus*-release farms, *M. raptor* accounted for 52.5% successful parasitism, while *M. raptorellus* accounted for 47.5% of pupae that produced a live parasitoid.

Successful parasitism, pupae that produced a live parasitoid, during the pre-release and release period are presented in Figure 6. None to very low parasitism was identified during the pre-release period and the first week of releases. Successful parasitism immediately increased on the six release farms and remained low on the no-release farms for the duration of the release period. Successful parasitism averaged 5.2% on the no-release farms, 62.5% on *M. raptorellus* farms and 57.4% on *M. raptor*/*M.raptorellus* farms during the release period. Figures 1 and 2 are from 2003 and are shown for comparison purposes (Rutz et al 2004).

Total parasitism is the number of pupae killed by parasitoids and represents the benefit (dead flies) to farmers that the parasitoids are providing. Total parasitism (uncorrected for control mortality) as presented here averaged 21.8% on no-release farms, 65.9% on *M. raptorellus*-release farms and 67.2% on *M. raptor*/*M.raptorellus*-release farms. These data indicate that the parasitoids were removing from 69-76% of flies from the calf bedding areas on *M. raptorellus*-release farms and 71-78% of flies from *M.raptor*/*M.raptorellus* release farms (Figure 7).

Based on these results, *M. raptorellus* and the 50:50 mix of *M. raptor and M.raptorellus* gave very similar control (fly pupal mortality) of the fly populations on their respective dairy farms. With the similarities taken into consideration, it merely comes down to the cost effectiveness of each release to the farmer. To release the *M.raptorellus*, it costs less then half of what it would to release the 50:50 mix. It would be most beneficial to have another year to fully compare and understand the differences between the two types of parasitoid releases in the 2006 study and to make certain that the record breaking NYS rainfall in 2006 was not a factor in how the parasitoids performed.

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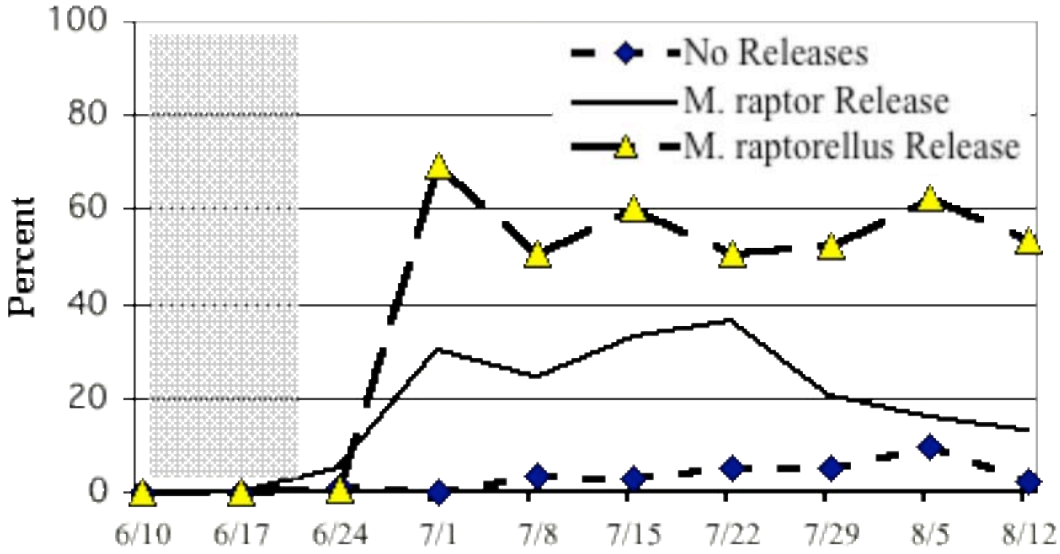

Figure 1. Successful parasitism from sentinel bags placed at nine New York dairies under three parasitoid release programs in 2003. Pre-release period identified by the shaded area.

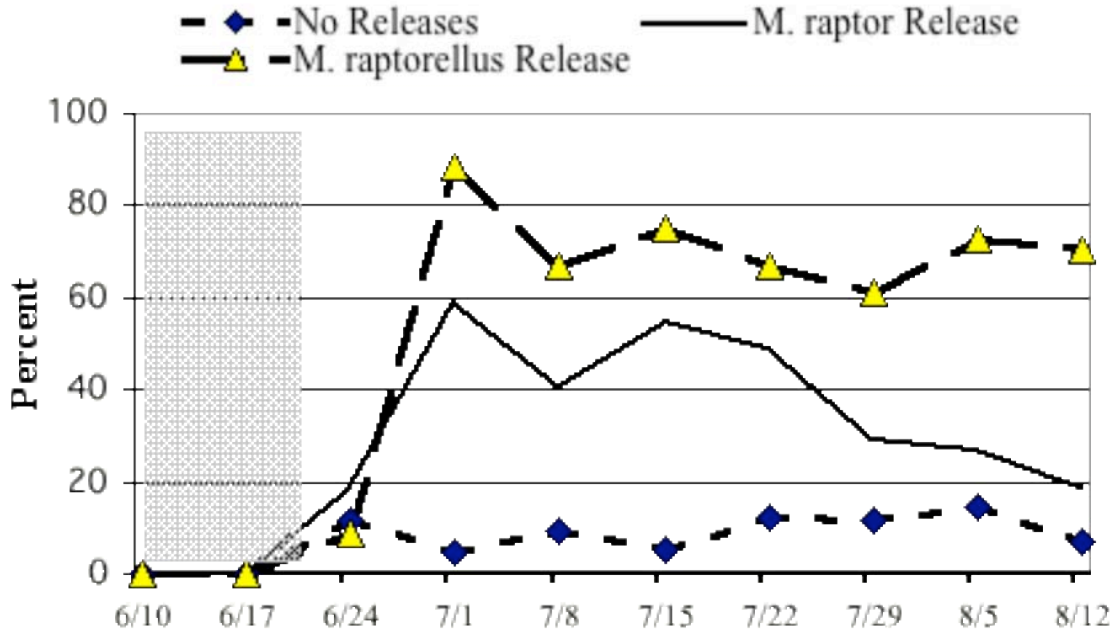

Figure 2. Percent of fly pupae killed at nine New York dairies under three parasitoid release programs in 2003. Pre-release period identified by the shaded area.

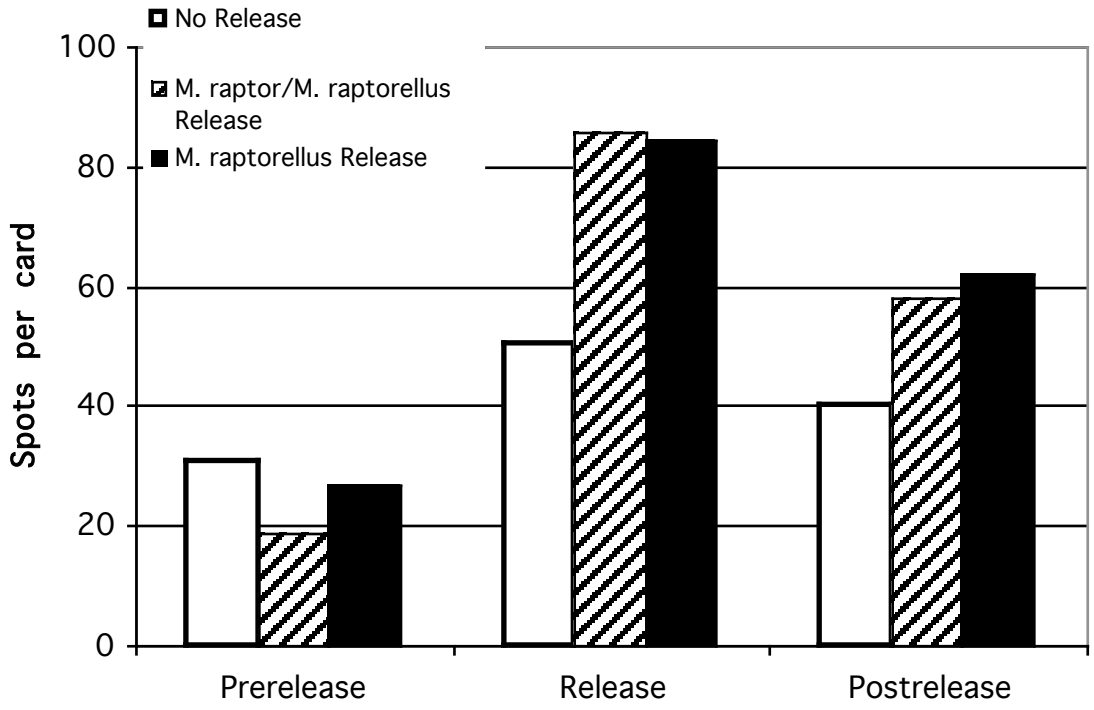

Figure 3. House fly population densities relative to release period and type of parasitoid released on nine New York dairies in 2006.

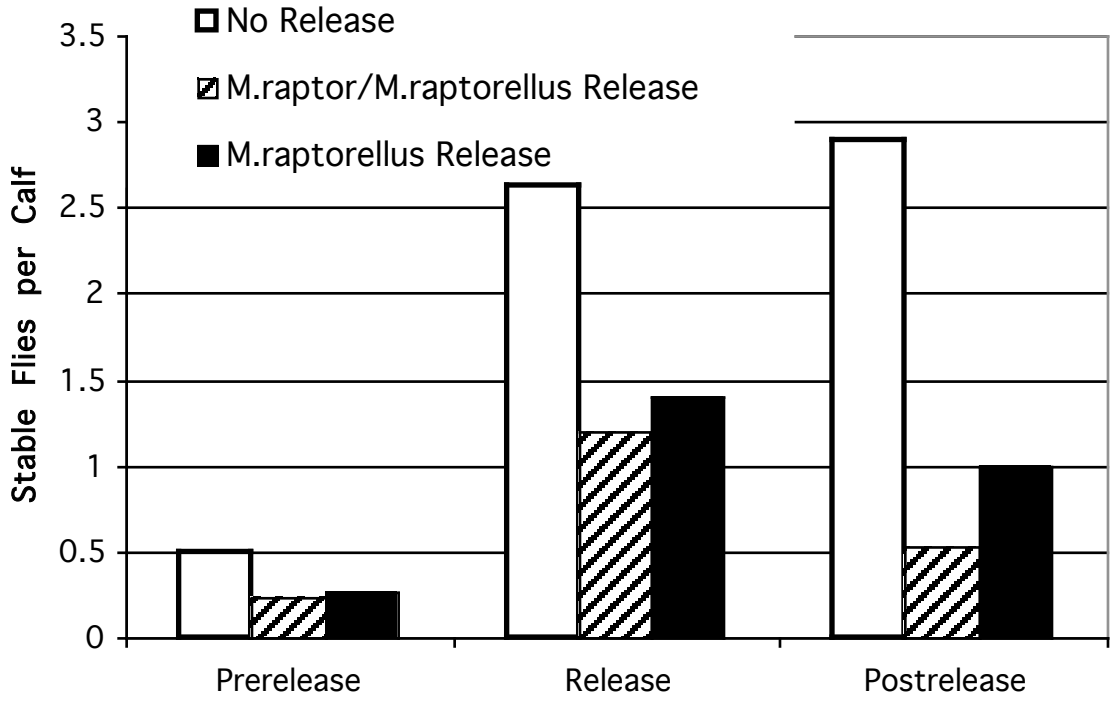

Figure 4. Stable fly population densities relative to release period and type of parasitoid released on nine New York dairies in 2006.

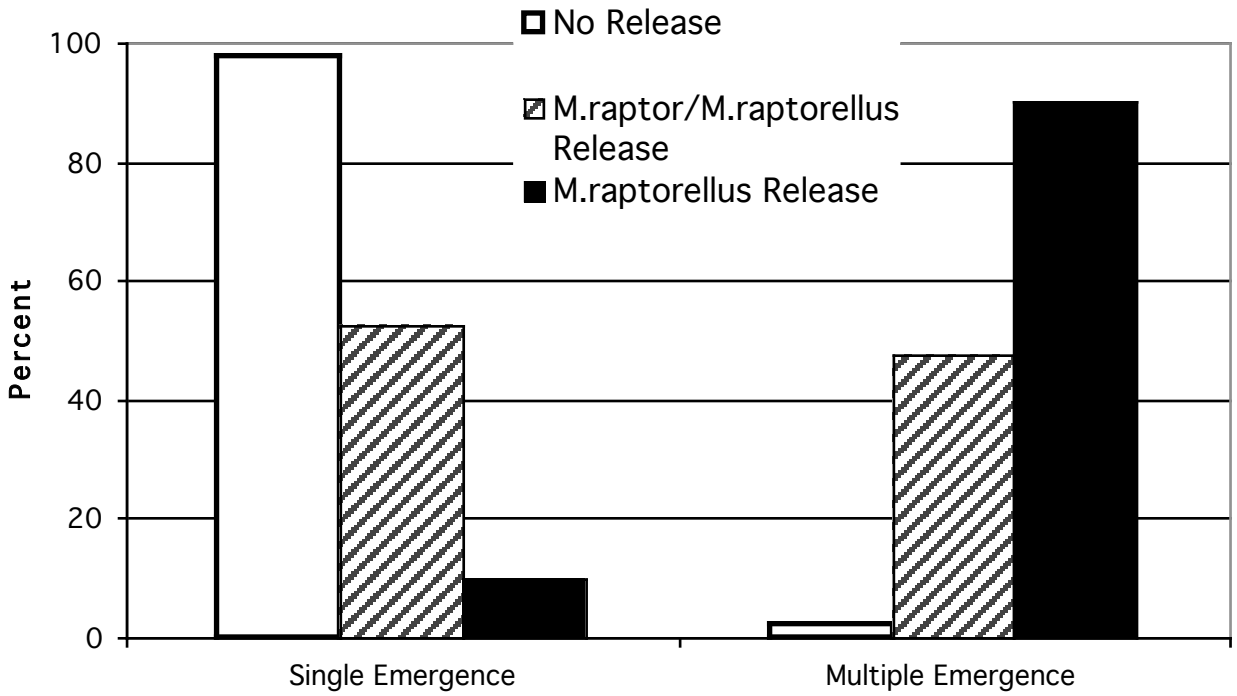

Figure 5. Percentage of species recovered from sentinel bags placed at nine New York dairies under three parasitoid release programs in 2006.

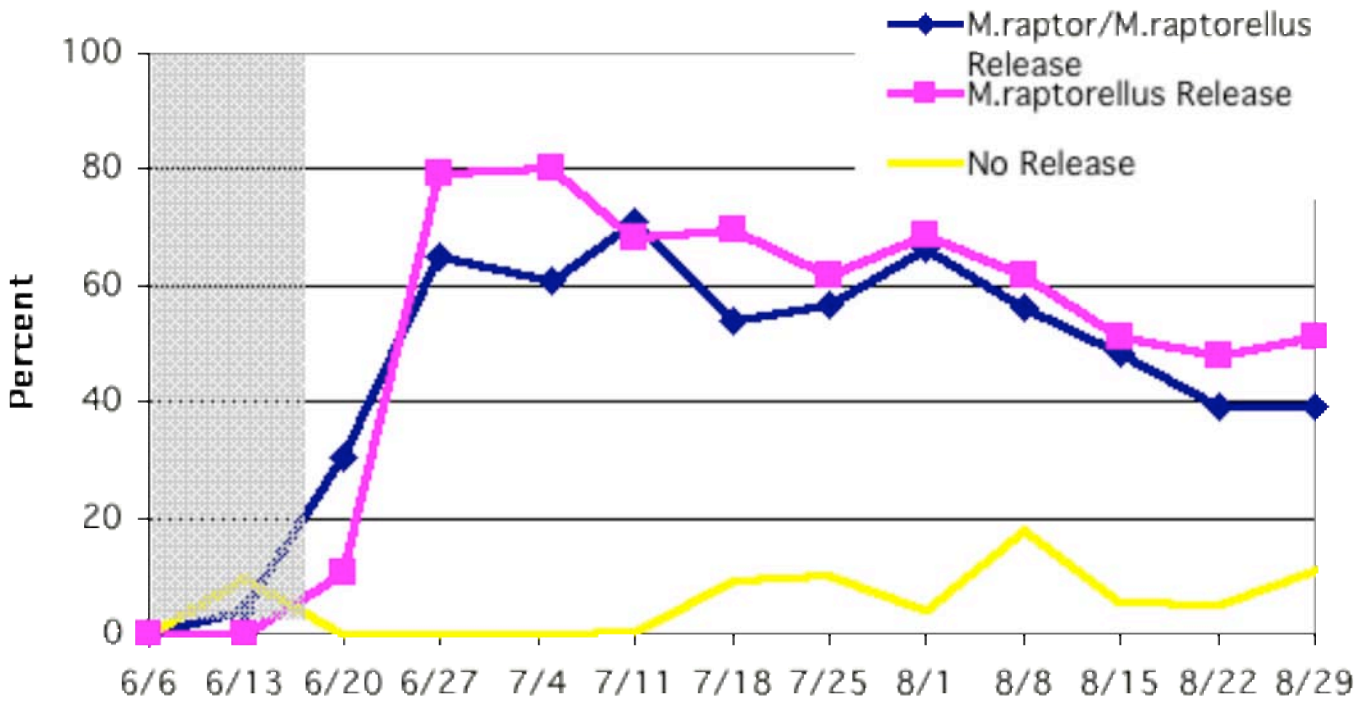

Figure 6. Successful parasitism from sentinel bags placed at nine New York dairies under three parasitoid release programs in 2006. Pre-release period identified by the shaded area.

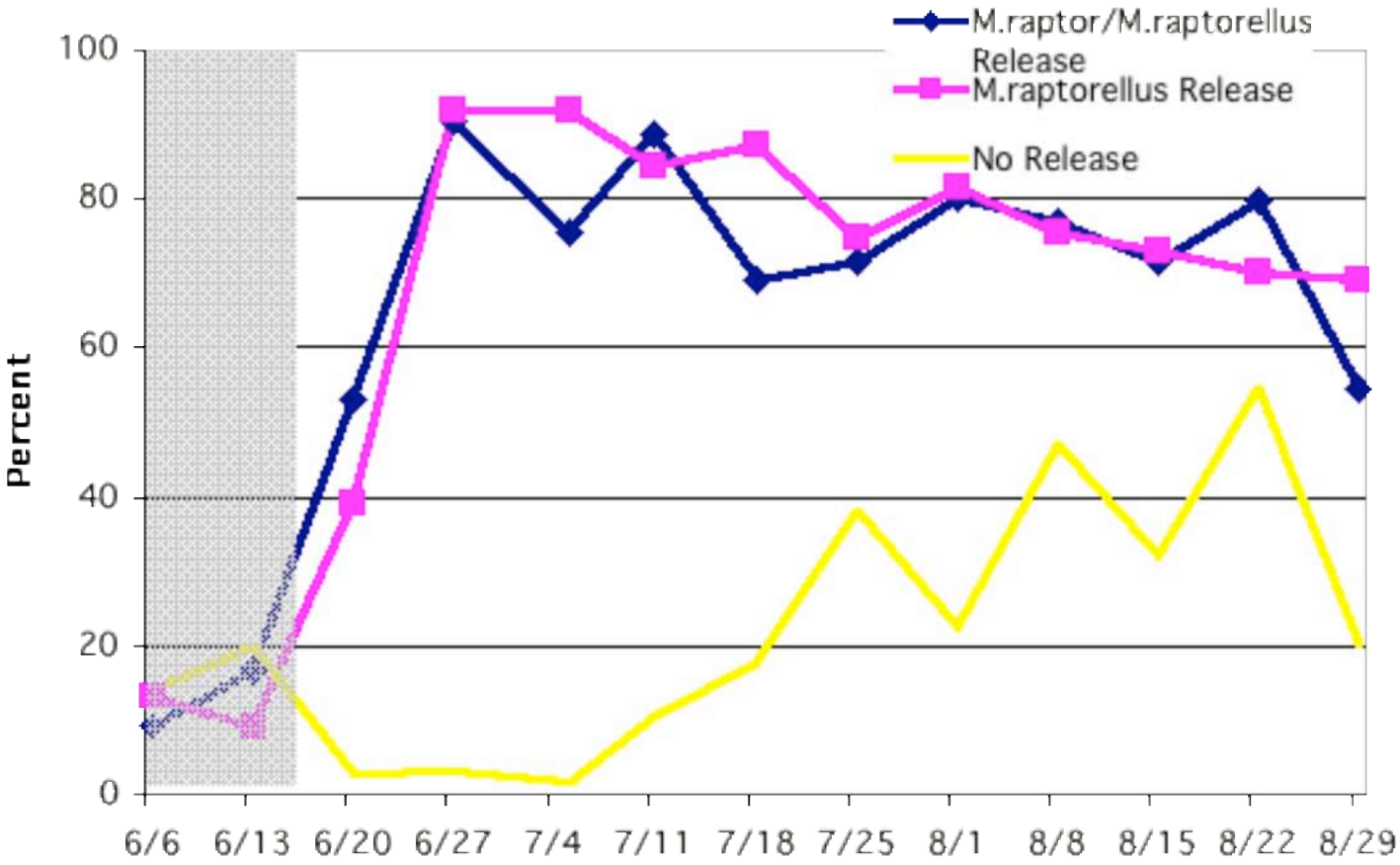

Figure 7. Percent of fly pupae killed at nine New York dairies under three parasitoid release programs in 2006. Pre-release period identified by the shaded area.